XVII. *Some further Observations on the Nature of the* Ergot *of Grasses. By* Edwin J. Quekett, *Esq., F.L.S., &c.*

Read December 20th, 1842.

In the third part of the eighteenth volume of the Transactions of the Linnean Society, are published my observations on the structure of the ergot of grasses, with a view to the discovery of the cause of that formation, which from numerous observations was there attributed to the grain becoming infected with a parasitic fungus, the nature of which was also described. It was stated that "the manner in which this singular production originates (for at present much respecting this part remains uncertain) is, that the sporidia, or more likely the nuclei within them, are by some means introduced into the interior of the grass and ultimately arrive at the grain, which they find the most suitable matrix for their development; or they may be brought into contact with the young grain from without, probably by the viscid fluid; but this is less likely to be the case, as the ergot can be detected before the paleæ have opened to admit the fluid."

Since the publication of the above theory of the production of ergot, experiments have been made to carry out the view there stated, and which have succeeded, I imagine, so far as to leave but little doubt as to the true origin of this substance.

The experiments were as follows. In the beginning of March 1840, twelve healthy grains of *rye*, of *wheat*, and of *barley* (grown in the neighbourhood of Epsom) were selected and placed in a shallow vessel, which contained a sufficient quantity of distilled water to moisten the grains, the whole being covered with a glass shade. In a few days germination commenced in nearly all the grains. At this period an ergot (taken by Prof. Henslow from some wheat grown in Suffolk the preceding year and given me by Dr. Pereira) was placed with the grains; and the sporidia, which were in abundance on its exterior,

were detached in the water by means of a pencil brush, and the body of the ergot was then removed.

A similar experiment was performed with the same number of grains of the several plants, but the sporidia were in this case obtained from an ergot found on *Elymus sabulosus*.

The growth of the young plants was allowed to proceed for several days, until, by the exhaustion of the albumen, the grains appeared wrinkled; the leaves having at this period attained the height of three or four inches. In this state the several young plants were packed in wet mould during the third week in March, conveyed into the country, and planted side by side in the garden of William Hyder, Esq., of Court Lees, near Canterbury, who had kindly undertaken to watch the progress of the experiment.

The greater number of the plants failed in their growth, so that, when the harvest had arrived, there only remained four of rye (one grown with the fungus of the ergot of *Elymus* and three with the sporidia derived from the ergot of wheat), three plants of barley and four of wheat.

The ears on the rye were remarkable, scarcely one having a healthy corn, the paleæ being generally quite empty; yet there were nine ears containing ergots, some having a single specimen, others as many as six. In the barley the ears were full of healthy grains, with one exception where there appeared to be a diseased grain; and in the wheat the ears were full and without disease*.

Considering that these results were not altogether satisfactory, from the fact that grains of the same sample had not been sown and allowed to germinate without coming in contact with the sporidia diffused in water (for if ergots could not be detected on these, but frequently on the others, it seemed that the question would be set at rest), another experiment was instituted in the following autumn after this manner:—

Twelve grains of rye, of wheat, and of barley, were again selected and made to germinate as before described; and the sporidia from the exterior of one of the ergots of rye, produced in the previous year, were diffused in the water.

* Whilst the ergots were making their appearance, I had the opportunity of confirming Philippar's assertion of their very rapid growth, and also of satisfying myself that the fluid found on these bodies had an internal origin.

The specimens, when arrived at the same state of forwardness as the first, were planted in October on the same estate, but not within half a mile of the former spot; and twelve healthy grains of each kind, with every care taken to prevent them from having any sporidia attached to them, were planted in the same locality.

From the extreme quantity of rain during last winter, very few of the grains either of the infected or of the uninfected kinds arrived at maturity; so that in August last there were growing only two of rye, two of wheat and one of barley of the infected, and one of each kind of the uninfected.

On each rye plant exposed to the sporidia an ergot was discovered, and, as before, the almost entire absence of unhealthy grains in the ears of the wheat and barley, which bore perfect and apparently healthy fruit as if nothing had interfered with their usual growth.

Of the uninfected grains planted at the same spot and period, only three plants arrived at maturity, but these presented no unhealthy appearance.

On reflecting on these results, it may appear that something is yet wanting to clear the subject of the obscurity that has hitherto enveloped it. I grant that if ergots had appeared in the wheat and barley, nothing apparently would have been wanting to convince the most sceptical of the true cause of this production; but if it be evident, or even probable, that any of the ergots of the two seasons were produced in the rye by infecting the grain with the fungus whilst germinating, it seems to me that one solitary instance would be as conclusive as if a multitude of species were diseased and each bearing many specimens.

If we consider what the grass is that becomes the most frequently affected with ergot, it is undoubtedly rye; and it is not too much to suppose that there may be something in the constitution or structure of this plant that makes it more susceptible of the infection than other grasses, or it may not be impossible that other grasses may be infected by a different proceeding: for instance, the sporidia of the fungus may be required to be introduced through the stomata, of which their diminutive size would admit, or they may enter through any accidental aperture in the cuticle.

The fact of ergots being produced on all the infected plants of rye during two sets of experiments, renders it highly improbable that accident should

have given rise to an occurrence happening so abundantly, which is undoubtedly of great rarity in this country in the ordinary course of events. Had the cause of the ergot been external, it is singular that as the wheat, barley and rye were growing side by side, the two former should have escaped being diseased and not the latter.

The absence of grains in most of the ears of the rye, even when no ergot was present, indicates that though the plants arrived at maturity, some cause must have so interfered with their usual habits as to suppress the development of the grain.

The inference that I conceive may be fairly drawn from these experiments is, that these ergots have been artificially produced by the process detailed; and it would appear most reasonable (even before the results of these experiments were known) to imagine that it must be so; for every ergot, on whatever grass it may be produced, is covered externally with a coating composed of the sporidia of a minute fungus, and these sporidia appear to be the same on all ergots. The inference necessarily follows, that they must be connected with its origin.

It cannot be imagined that every ergot when arrived at maturity acquires its coating of the fungus from external sources: if so, ergots unaccompanied with the fungus ought sometimes to be found, which never have been, if the examination has been made while they retain their position in the ear; and besides, the young ergot possesses it even before the flowers expand.

Shortly after expressing opinions similar to these, which were published in part iii. vol. 18. Trans. Linn. Soc., a paper was read on January 21, 1840, from the late Mr. Francis Bauer, who stated that he had not detected the fungus in his examination of ergot in the years 1805 to 1809, but that he had observed it in 1838; yet, to use his own words, he still maintains, "I am not yet convinced that these filamentous fungi with numerous sporidia are the cause or the consequence; because,

"1st, Every gramineous plant is equally infected with that minute filamentous fungus, yet very few of these plants produce ergots; and among agricultural grains, the rye is the only one that is subject to that disease; among the many hundred ears of wheat that I examined in every stage of its growth, I found

only one spikelet that produced three ergots, and one spikelet with only one ergot.

" Because, 2nd, in autumn all decaying plants are infected with such filamentous fungi and minute sporidia; and Mr. Smith, when he brought to me the first specimen of his ergot, brought me also a specimen of a flower of *Canna indica*, in which not only the inside of the anther was infected with this filamentous fungus, but also the individual pollen grains were strongly infected with it."

On the first head, it may be observed that no doubt, from something inexplicable at present, the rye is the most frequently ergotized of the agricultural grains; still Mr. Bauer acknowledges to have found wheat similarly diseased, and others have found barley and oats.

On the second point, with reference to finding the fungus on other plants and on decaying vegetable matter, without any formation like an ergot, this fact does not appear to me to be opposed to the view which I have taken. It cannot be supposed that all fungi of this character attack one plant exclusively, or grow only in one situation. It is often found that fungous parasites do not confine themselves to one particular plant or organ, but are found to pass through the systems of different plants, and develope themselves on different organs. Thus, on the authority of the Rev. M. J. Berkeley (in Sir W. J. Hooker's 'English Flora,' part ii. vol. v.) it is stated that *Uredo segetum* attacks not only wheat, but barley, oats and other grasses; *Puccinia graminis* attacks the leaves and culms of various grasses; and *Puccinia striola* attacks *Carices*, *Junci* and species of *Allium*.

In my own experiments it was shown that the fungus peculiar to the ergots could be made to grow between moistened glasses, and consequently apart from the grain. It may, therefore, have many situations favourable to its growth; but because an ergot does not accompany it in its growth in all situations, it is not on this account to be inferred that it cannot produce an ergot when it selects the grain as its matrix, any more than it can be maintained, if *Cynips quercus petioli* lays its egg in the bark of the oak and no gall follows, that it is not the origin of that excrescence when it deposits its egg in the bud. It is necessary, I conceive, that to produce an ergot (which is decidedly a diseased grain) the attack can only be effectual on grami-

neous plants, or those having the ovary and seed similarly organized and analogous in chemical composition. It may not be improbable that the same fungus can create disease in other seeds, but then the form of the disease would be certainly unlike the figure of an ergot.

We have learned from Mr. Bauer that he could produce "smut" and some other diseases of grasses, by infecting the plants in early life with the sporules of particular fungi; it cannot, therefore, be difficult to conceive that other fungi possessing somewhat different effects, may also be taken into the interior of the same plants. The possibility then being proved of the introduction of the germs of fungi into grasses, each producing a different result according to its nature, I cannot help being impressed that the growth of the fungus, which is always found on the exterior of every ergot, can, when it attacks the grain of grasses, so alter its healthy character as to convert it into the diseased form so well known by its size and colour from perfect grains of the same plant.